

Aftereffects Associated with One or Two Stressors Across Conditions of Complete, Partial, or No Control

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Abstract

This study examined human aftereffects (i.e., psychological, behavioral, and physiological) associated with one or two stressors (i.e., noise, noise and/or a strobe light) over three levels of control (i.e., no, partial, or complete) where control could be repeatedly exerted to terminate the stressor(s). The new concept of partial control, rather than complete or no control, is more analogous to the many daily interactions humans face. Greater psychological, behavioral, and physiological aftereffects were associated with two stressors or the uncontrollable conditions; partial or complete control conditions were analogous to the comparison (no stressor/no control) group. Urinary catecholamines (i.e., epinephrine and norepinephrine) paralleled these findings showing greater arousal when control was absent than when control was available. Men had significantly greater catecholamine levels than did women.

Introduction

Background

In the past decade research has focused on the aftereffects of stress. Aftereffects are traditionally thought of as those behavioral anomalies that are found immediately after the stressor is terminated, such as a decreased tolerance for frustration, diminished proofreading performance, and less ability to deal with response competition (Glass & Singer, 1972). The term "stressor" is used to refer to stimulation that represents an adaptive threat or potential adaptive threat to the organism. The present study was concerned with two major issues; behavioral and physiological aftereffects associated with complete, partial, or no control over terminating the stressor(s) and aftereffects associated with exposure to one or two stressors.

Method

Two different stressors were used in this study. The first was a loud noise (95 dba) delivered over headphones. The second was a flashing strobe light placed at eye level approximately two feet away from the subject's head. Crossed with stressor conditions were varying conditions of complete, partial, or no control. For each combination of stressors, there was a control condition and a no control condition (e.g., could or could not terminate the stressors). Partial control referred to a condition in which noise and light were presented but subjects could only terminate the noise. Complete control referred to conditions in which one or two stressors were presented and subjects could terminate the stressor(s). No control referred to conditions in which one or two stressors were presented but could not be terminated.

Procedures

All subjects were recruited and randomly assigned to conditions and were paid \$10.00 for their participation. Informed consent was obtained in accordance with the University's guidelines for human subjects. Two urine samples were obtained, one before and one after the session; these were preserved for later assay. Subjects provided demographic information and were instructed in the use of the equipment.

Next, the subjects solved aloud a number of machine paced mental arithmetic tasks, while being exposed to manipulations of control and exposure to stressor(s). Each presentation of a stressor was unpredictable (e.g., no warning of its onset) and each was presented 18 times for 8 seconds at predetermined random intervals throughout the 21 minute session. Subjects either exerted control or attempted to do so, by pressing calculator type keys in their efforts to terminate the stressor(s). The subjects in the control conditions were informed of the sequence necessary to terminate the stressor(s). Subjects in the no control conditions were told some sequence of numbers would terminate the stressor(s) when in fact no solution existed.

Immediately following the arithmetic problem presentation, a five minute proofreading task was administered, followed by a persistence task and a visual perception task. The proofreading task involved identifying and circling misspellings, grammatical mistakes, incorrect punctuation, and typographical errors. The timed decision-making task required determination of which two shapes was the longer. The object of the persistence task was to predict the next letter that would logically follow a previous sequence of letters. The subjects were presented with up to 16 letters one at a time and could terminate this solvable procedure whenever they chose. The subjects proofreading performance, time to reach a decision on the decision-making task, and the time spent on the persistence task, were used to detect the presence of aftereffects. Additionally, psychoendocrine measures of poststressor arousal were measured using a double urinary void, through which change scores were derived. A final questionnaire, which included manipulation checks, was completed prior to debriefing the subjects.

Results

It was predicted that greater aftereffects would occur as the number of stressors increased and control decreased. The design of this study required data to be analyzed using planned comparisons and are presented as means with higher values reflecting more of the given dimension. All catecholamine data are reported as changes in excretion levels (in ng/ml).

Manipulation Checks

Two manipulation checks were used in this study. The first manipulation check asked the subjects to indicate the number of stressors (i.e., 0, 1, or 2) to which they had been exposed during presentation of the arithmetic problems. All subjects correctly identified the number of stressors. The second manipulation check asked the subjects to indicate the amount of control they felt they had over the stressor(s). Perceived control was associated with the manipulations of control.

Replication of aftereffect findings

Previous research (Cohen, 1980; Glass & Singer, 1972) has demonstrated aftereffects following exposure to stressors by asking subjects to work on proofreading and persistence tasks. Using the same arithmetic problems and proofreading task as Glass and Singer (1972), similar aftereffects were found in the present study. Subjects who were not exposed to any stressor found more errors ($\bar{x} = 64.9\%$) in the passage that they proofread than did subjects exposed to one or more stressor(s) ($\bar{x} = 52.7$; $t(64) = 2.45$, $p < .017$).

Glass and Singer (1972) also found that having perceived control over a stressor reduced aftereffects of exposure to the stressor. The present study provided subjects with actual control which was repeatedly exerted, and found the same pattern of aftereffects reported by Glass and Singer (1972). Comparison of subjects' proofreading performance in the no control ($\bar{x} = 48.95\%$) and complete control conditions ($\bar{x} = 59.55\%$) revealed significant aftereffect differences, $t(64) = 2.45$, $p < 0.17$. Having control, even when the control required work or effort in order to be maintained, was associated with better performance than was not having any control over the stressor. This pattern was also revealed on the persistence task. Subjects in the no control conditions persisted less ($\bar{x} = 85.45$ seconds) than did those subjects in the conditions of complete control ($\bar{x} = 164.55$ seconds), $t(64) = 5.37$, $p < .001$.

The present study sought to expand research on aftereffects associated with exposure to stress in several ways. First, the effects of exposure to more than one stressor were considered. As predicted, in the no control conditions, subjects' proofreading performance was better when one stressor was present ($\bar{x} = 56.0\%$) than when two were used ($\bar{x} = 41.9\%$) $t(64) = 2.49$, $p < .015$. Similarly, persistence decreased as the number of stressors increased ($\bar{x} = 164.5$ seconds vs. 85.5 seconds), $t(64) = 5.37$, $p < .001$.

When control was provided over both stressors, the effect was less dramatic. Exposure to one stressor-with control was associated with better proofreading performance ($\bar{x} = 65.5\%$) than was exposure to two stressors-with control of both ($\bar{x} = 53.6\%$) but this was only marginally significant $t(64) = 1.82$, $p < .07$. There were no significant differences on the persistence task between the two stressors with control ($\bar{x} = 152.7$ seconds) or one stressor with control ($\bar{x} = 176.4$ seconds) conditions, $t(64) = 0.58$, $p < .57$.

Thus far we have shown that the effects of perceived and actual control in laboratory studies of stress are comparable and that exposure to two stressors has more negative aftereffects than does exposure to one stressor, primarily when control is not available. As noted earlier, research on aftereffects has been restricted to conditions of either no control or complete control. This study additionally examined the aftereffects of exposure to stress under partial control. Significant aftereffect differences were noted between the subjects in the two stressor-partial control and the two stressor-no control conditions. Subjects in the two stressor-no control condition performed more poorly on the proofreading task ($\bar{x} = 46.7\%$ vs. $\bar{x} = 41.9\%$) $t(64) = 9.72$, $p < .001$, and their persistence was less ($\bar{x} = 120.2$ seconds vs. $\bar{x} = 67.4$ seconds) $t(64) = 4.15$, $p < .001$ than subjects in the partial control condition. Similarly, the subjects' proofreading performance in the two stressor-no control condition was significantly lower ($\bar{x} = 41.9\%$) than the subjects in the two stressor condition with control ($\bar{x} = 53.6\%$), $t(64) = 11.15$, $p < .001$. This suggests that partial and complete control are

associated with fewer or less severe aftereffects than the multistressor-no control condition. Analyses between the partial control and the two stressor-control conditions revealed no significant aftereffect differences on any of the dependent variables.

The present research also examined psychoendocrine measures of arousal during the session. The catecholamine levels showed a main effect for control and for gender. The epinephrine (i.e., change scores) were significantly greater in the no control conditions than in the complete control conditions $t(48) = 2.49, p < .015$. Analyses of these changes between the partial control and the no control conditions indicated greater physiological arousal in the latter conditions, $t(28) = 2.23, p < .03$. Epinephrine levels reflected significantly greater increases for men ($\bar{X} = 7.12$ ng/ml) than for women ($\bar{X} = 2.15$ ng/ml) $t(28) = 23.07, p < .001$, in the no control conditions. When subjects had control over terminating the stressor(s), the epinephrine levels between men and women were not significantly different $t(18) = .64, p > .05$. Collapsing across conditions, men's epinephrine levels were greater ($\bar{X} = 4.6$ ng/ml) than were the women's ($\bar{X} = 2.6$ ng/ml), $t(48) = 14.49, p < .001$. These analyses revealed a main effect for conditions of control as well as for gender. Norepinephrine change scores reflected similar trends.

Discussion

This study suggests that when control is available, exposure to environmental stressors results in few, if any, aftereffects. The post-stressor effects of exposure to none, one, or two stressors were measured across conditions of complete, partial, or no control. Partial or total control was associated with fewer poststressor decrements than were the no control conditions. Further, multistressor conditions were associated with greater aftereffects than were single stressor conditions. These findings have a number of implications for understanding both environmental stressors and their impacts on behavior, performance, and safety. The additional work of exercising control, even if it is only partial control, appears to have ameliorative effects that outweigh the negative aspects of increased responsibility.

The notion of uncontrollable stress resulting in a sense of helplessness has been explored in various research settings (Seligman, 1975). Seligman, Maier, and Geer (1968) have proposed a theory of Learned Helplessness. This theory plays a central role in explaining our subjects' behavioral differences and basically states that when the outcomes are independent of the inputs, the organism learns to be helpless. Thus, incentives for initiating actions aimed at avoiding the aversive event are absent. Conversely, when the subjects are able to control these aversive stimuli, they will be facilitated in performing their escape and avoidance behaviors, thereby avoiding the additional anxiety produced by the feelings of learned helplessness. In both cases, the subjects' behavior can be viewed as adaptive.

Interestingly, it appears that it is not the stressor(s) per se, that produces discontinuity of performance, but rather the individual's perception of control in the context of stressful experience, which can later effect behavioral functioning. To understand the psychological processes behind these differential behaviors has implications for all segments of the military and society. While the present study has expanded the current knowledge on aftereffects to include two stressors, and a partial control condition, more laboratory and field research is needed before we fully understand the impact

that aftereffects have upon our behaviors, health or in dubious acts against society.

References

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